REMARKS

Reconsideration and withdrawal of the rejections set forth in the Office Action dated September 22, 2010, are respectfully requested in view of this Response. Claims 1, 4-6, 8, 9, 12, 16, 18, 20-35, 37 and 39-49 are pending in this application. Claims 2, 3, 7, 10, 11, 13-15, 17, 19, 36 and 38 were previously canceled without prejudice or disclaimer, for the sole purpose of advancing prosecution. Claims 46-49 are newly presented.

In the outstanding Office Action, the Examiner objected to claims 32-34 because of informalities. The Examiner also rejected claims 1, 4-6, 12, 16, 18, 20, 23, 27-30, 39-42, 44 and 45 under 35 U.S.C. §103(a) as being assertedly unpatentable over U.S. Patent No. 4,394,573 to Correa et al. (hereinafter referred to as "Correa et al.") in view of U.S. Patent No. 4,517,458 to Barringer (hereinafter referred to as "Barringer") and PCT Publication WO 03/023379 to Tokhtuev et al. (hereinafter referred to as "Tokhtuev et al."); rejected claims 8 and 9 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. as applied to claim 1, and further in view of U.S. Patent No. 6,372,895 to Bentsen et al. (hereinafter referred to as "Bentsen et al."); rejected claims 21, 22 and 43 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. as applied to claims 20 and 43, and further in view of U.S. Patent No. 3,666,945 to Früngel et al. (hereinafter referred to as "Früngel et al."); rejected claims 24-26 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. as applied to claim 23, and further in view of U.S. Patent No. 6,121,053 to Kolber et al. (hereinafter referred to as "Kolber et al."); rejected claims 31 and 35 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. as applied to claims 1 and 18, and further in view of U.S. Patent No. 6,157,033 to Chudnovsky (hereinafter referred to as "Chudnovsky"); rejected claim 32 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. as applied to claim 1, and further in view of U.S. Patent Application Publication No. 2005/0174793 to Field (hereinafter referred to as "Field"); rejected claim 33 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. as applied to claim 1, and further in view of U.S. Patent No.

3,554,653 to Zielke et al. (hereinafter referred to as "Zielke et al."); rejected claim 34 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer, Tokhtuev et al. and Kolber et al. as applied to claim 24, and further in view of U.S. Patent No. 4,005,605 to Michael (hereinafter referred to as "Michael"); and rejected claim 37 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. as applied to claim 44, and further in view of U.S. Patent No. 5,947,051 to Geiger (hereinafter referred to as "Geiger").

Claims 46-49 are newly presented to highlight additional differentiating features, for the sole reason of advancing prosecution. Claims 32-34 have been amended to correct a typographical error. Applicants reserve the right to reassert the original claim scope of any claim in a continuing application. The amended claims are fully supported throughout the claims, specification and figures as originally filed. Applicants respectfully submit that the amendments introduce no new matter within the meaning of 35 U.S.C. § 132.

Applicants request reconsideration and timely withdrawal of the pending objections and rejections for at least the reasons discussed below.

Objection to the Claims

The Examiner objected to claims 32-34 for informalities, asserting that "the limitation 'during use and/or though' should be --during use and/or through--" and required appropriate correction. *See* Office Action page 2.

Response

By this Response and Amendment, claims 32-34 have been amended to replace the phrase "during use and/or though" with "during use and/or through." Accordingly, Applicants respectfully submit the objection has been obviated, and request reconsideration and withdrawal of the objection.

Claim Rejections under 35 U.S.C. §103(a)

The Examiner rejected claims 1, 4-6, 12, 16, 18, 20, 23, 27-30, 39-42, 44 and 45 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. in view of Barringer and Tokhtuev et al.; rejected claims 8 and 9 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al., and further in view of Bentsen et al.; rejected claims 21, 22 and 43 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al., and further in view of Früngel et al.; rejected claims 24-26 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al., and further in view of Kolber et al.; rejected claims 31 and 35 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al. and further in view of Chudnovsky; rejected claim 32 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al., and further in view of Field; rejected claim 33 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al., and further in view of Zielke et al.; rejected claim 34 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer, Tokhtuev et al. and Kolber et al. and further in view of Michael; and rejected claim 37 under 35 U.S.C. §103(a) as being assertedly unpatentable over Correa et al. as modified by Barringer and Tokhtuev et al., and further in view of Geiger.

Response

Applicants traverse the rejections as all of the features of the presently claimed subject matter are not disclosed, taught or suggested by the cited prior art of record. To establish a *prima facie* case of obviousness, the Examiner must establish that the prior art references teach or suggest all of the claim features. *Amgen, Inc. v. Chugai Pharm. Co.*, 18, USPQ2d 1016, 1023 (Fed. Cir. 1991); *In re Fine*, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988); *In re Wilson*, 165 USPQ2d 494, 496 (CCPA 1970).

A *prima facie* case of obviousness must also include a showing of the reasons why it would be obvious to modify the references to produce the present invention. *See Dystar Textilfarben*

GMBH v. C. H. Patrick, 464 F.3d 1356 (Fed. Cir. 2006). The Examiner bears the initial burden to provide some convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings. *Id.* at 1366.

Overview

Correa et al. describes a "[m]ethod and apparatus for detecting the presence of hydrocarbons and other substance that fluoresces or absorbs light within a body of water which utilizes a controlled submersible vehicle scanning at or near the water bottom. The method utilizes a selected frequency light source as carried by the submersible to scan the water bottom, and the returned light energy, either at the wavelength of oil fluorescing in water or the source frequency backscatter, is detected and processed for the water bottom as well as a water region that is a selected distance above the water floor. Alternative forms of apparatus are disclosed for carrying out the functions of both oil fluorescence detection, and for obtaining differential absorption readings as to light source backscatter energy that is created by the ambient water and other factors in the water environmentsuch [*sic*] as marine life, turbidity, etc." *See* Correa et al. Abstract.

Barringer describes "[a] method of detecting hydrocarbon seeps in a sea or in earth.... The method involves interrogating aerosols formed above the sea or earth surface with an intense beam of primary light radiation generated aboard an aircraft or other vehicle. The spectral composition of the beam is selected to induce secondary light radiation in certain hydrocarbon materials contained in aerosols generated by hydrocarbon seeps rising to the sea or earth surface. The secondary light radiation is detected aboard the aircraft and subjected to spectral analysis to determine whether the composition of the aerosols is characteristic of aerosols generated by hydrocarbon seeps. Apparatus for implementing the method is...." *See* Barringer Abstract.

Tokhtuev et al. describes "[a] multichannel fluorosensor (100) includes an optical module (1) and an electronic module (7) combined in a watertight housing (101) with an underwater connector (102). The fluorosensor (100) has an integral calibrator for periodical sensitivity validation of the fluorosensor (100). The optical module (1) has one or several excitation channels (5, 6) and one or several emission channels (3, 4) that use a mutual focusing system (2). To increase

the efficiency of this mutual focusing system (2), the excitation and emission channels each have a micro-collimator made with one or more ball lenses (22). Each excitation channel has a light emitting diode and an optical filter. Each emission channel has a photodiode with a preamplifier and an optical filter. The electronic module (7) connects directly to the optical module (1) and includes a lock-in amplifier, a power supply and a controller...with an A/D converter and a connector." *See* Tokhtuev et al. Abstract.

Bentsen et al. describes "novel coumarin based fluorogenic compounds useful in assaying for biological activity. Specifically, these fluorogenic compounds exhibit fluorescence at particular wavelengths when cleaved by target enzymes. Preferred compounds include sugar and peptide derivatives of umbelliferone derivatives bearing a heterocyclic five membered ring at the 3-position. These compounds can be used for rapidly detecting food pathogens and for determining sterilization effectiveness. The compounds may also be used in a form bounded to a polymeric support or to a biomolecule or macromolecule." *See* Bentsen et al. Abstract.

Früngel et al. describes "[a]n arrangement through which the concentration of fluorescent materials, when present in low quantities, may be measured within a fluid. A transmitter is flashed periodically at a rate corresponding to the rate that measurements are taken, for the purpose of exciting the fluorescent materials. Filters and optical systems are provided at the transmitter for transmitting the appropriate light. A receiver spaced from the transmitter or light source is also equipped with appropriate filters and optical systems, and receives on a photosensor, the radiation from the fluorescent materials. The resultant electrical signals from the photosensors are amplified and compensated against daylight and cloudy effects of the medium, through an auxiliary amplifier." *See* Früngel et al. Abstract.

Kolber et al. describes that "[a] multiple protocol fluorometer measures photosynthetic parameters of phytoplankton and higher plants using actively stimulated fluorescence protocols. The measured parameters include spectrally-resolved functional and optical absorption cross sections of PSII, extent of energy transfer between reaction centers of PSII, F_0 (minimal), F_m (maximal) and F_v (variable) components of PSII fluorescence, photochemical and non-photochemical quenching, size of the plastoquinone (PQ) pool, and the kinetics of electron transport

between Q_a and PQ pool and between PQ pool and PSI. The multiple protocol fluorometer, in one embodiment, is equipped with an excitation source having a controlled spectral output range between 420 nm and 555 nm and capable of generating flashlets having a duration of 0.125-32 μs, an interval between 0.5 μs and 2 seconds, and peak optical power of up to 2 W/cm^2. The excitation source is also capable of generating, simultaneous with the flashlets, a controlled continuous, background illumination." *See* Kolber et al. Abstract.

Chudnovsky describes "[a] method and apparatus for remote detection of gas leak and determination of the relative concentration of a gas using nondispersive infrared absorption of backscattered laser light with background compensation. The method includes source of coherent infrared radiation, sealed reference cell, filled with air with admixture of reference gas of known concentration, sealed control cell filled with air, sensitive elements which are sensitive to radiant fluxes in a determined band of wavelengths. The method includes measuring output signals, calculating the difference of the signals from control cell for different points, the difference of signals from reference cell and control cell, the ratio of said differences and relative concentration, and means for converting said concentration into visual image and audio signal. The apparatus includes camera or video camera to record a visual image of an object at the point where the maximum relative concentration was recorded and laser pointer to indicate a position of invisible infrared beam on a target." *See* Chudnovsky.

Field describes "[a]n automotive headlight assembly includes a concave parabolic reflector having a focal axis and a focal point on the axis spaced from the reflector surface. A halogen light source is mounted on an elongated tubular conduit that is oriented on the focal axis of the parabolic reflector. A power mechanism is connected to the tubular conduit for sliding the conduit through a clearance opening aligned with the focal axis, so that the light source is moved between a high beam position on the focal point and a low beam position located at a different point the focal axis, through an infinite number of in between positions, thus allowing the driver to adjust the focal point of the light to any desired distance." *See* Field Abstract.

Zielke et al. describes that "[a]n improved autocollimator employs a pair of modulated light sources and a pair of plane reflecting surfaces to direct the light out through an objective lens.

Between the reflecting surfaces is a window or slit, and behind the slit a light sensor. The purpose of the autocollimator is to direct light onto an external reflector and measure sensitively the direction of the reflection. The reflected light reenters the objective and forms an image which may fall centered on the slit or may fall displaced with respect to the slit. The displacement of the image is a measure of the angular deviation of the returning light beam and is displayed on a zero-center indicator controlled by the light sensor through phase-sensitive circuitry." *See* Zielke et al. Abstract.

Michael describes that "[a] radiation detector senses ambient radiation within the cavity of an instrument, and then radiation from a target object, the sensed radiation from within the cavity following substantially the same optical path within the instrument as the radiation from the target object, thus minimizing error due to internal cavity temperature and other disturbances during measurement of radiation from the target object." *See* Michael Abstract.

Geiger describes "[a]n underwater self-propelled surface-adhering robotically operated vehicle capable of being navigated through a volume of water and of adhering itself to an underwater surface and traversing along the surface. The vehicle has a main body with an interior suction chamber and a motor driven impeller disposed in the chamber to draw water through the bottom end of the chamber and expel it at the top end and thereby create a negative pressure force at the bottom end to maintain the vehicle in contact with the underwater surface. Thrusters on the main body allow the vehicle to be driven through a volume of water before and after attachment to the underwater surface as well as to hold station in mid water for tasks and inspections. The vehicle may be provided with an evacuable enclosure to provide an environment for task accomplishment and with measurement and inspection devices and tools for underwater hull cleaning, welding, and other underwater tasks." *See* Geiger Abstract.

Independent claim 1 recites [a] fluorometer for detecting the level of fluorescent material in a body of water, the fluorometer comprising:

> an excitation system including an excitation source for producing excitation light capable of causing fluorescence in fluorescent material; and
> a detection system for detecting said fluorescence, wherein
> *said excitation system comprises an excitation source comprising one or more light emitting diodes (LEDs)*, the excitation system further comprising *means to cause said excitation light to form, in use, a generally conical divergent*

> *beam projecting from the fluorometer, said beam causing means comprising at least one collimating lens*, said excitation system further including means for modulating said beam with a modulating signal having a modulating frequency, and wherein
>
> said detection system comprises means for receiving light and for converting said received light into a corresponding electrical signal, and at least one lens arranged to direct said received light onto said light receiving and converting means, *wherein said at least one lens of the detection system is arranged to provide a generally conical convergent detection volume for the detection system, said generally conical detection volume converging in a direction towards said fluorometer and at least partially overlapping with said generally conical divergent beam* and wherein
>
> said detection system further includes means for detecting, in the electrical signal produced by said light receiving and converting means, a signal component of substantially the same frequency as said modulation frequency, said detecting means including *means for performing spectral analysis of said electrical signal and means for determining the value of a spectral component of said electrical signal corresponding to said modulation frequency*,
>
> wherein *said detection system is arranged to determine the level of fluorescent material present in said body of water depending on said value of said spectral component*, such that *the fluorometer is capable of detecting fluorescent material located remotely from the fluorometer in said body of water.*

Emphases added.

Independent claim 42 recites [a] fluorometer for detecting the level of fluorescent material in a body of water, the fluorometer comprising:

> an excitation system including an excitation source for producing excitation light capable of causing fluorescence in fluorescent material; and
>
> a detection system for detecting said fluorescence, wherein
>
> *said excitation system comprises an excitation source comprising one or more light emitting diodes (LEDs), the excitation system further comprising means for causing said excitation light to form, in use, a generally conical divergent beam projecting from the fluorometer, said beam causing means comprising at least one collimating lens* arranged to cause said excitation light to form a substantially collimated elongate beam that projects, during use, from the fluorometer, and said excitation system further including means for modulating said collimated elongate beam with a modulating signal having a modulating frequency, said excitation system being arranged such that said *beam is capable of causing fluorescence in fluorescent material at distances of up to several meters from the fluorometer*, and wherein

said detection system comprises means for receiving light and for converting said received light into a corresponding electrical signal, and at least one lens arranged to direct said received light onto said light receiving and converting means, *wherein said at least one lens of the detection system is arranged to provide a generally conical convergent detection volume for the detection system, said generally conical detection volume converging in a direction towards said fluorometer and at least partially overlapping with said generally conical divergent beam*, and wherein

said detection system further includes means for detecting, in the electrical signal produced by said light receiving and converting means, a signal component of substantially the same frequency as said modulation frequency, *said detecting means including means for performing spectral analysis of said electrical signal and means for determining the value of a spectral component of said electrical signal corresponding to said modulation frequency,* wherein said detection system is arranged to determine the level of fluorescent material present in said body of water depending on said value of said spectral component such that *the fluorometer is capable of detecting fluorescent material located remotely from the fluorometer at distances of up to several meters from the fluorometer in said body of water*,

and *wherein the excitation system and the detection system are each provided in a respective housing, the respective housings being located adjacent one another and arranged such that there is an overlap, during use, between said generally conical divergent beam emanating from the excitation system housing and said generally conical convergent detection volume of the detection system housing,*

and wherein the respective housings have a respective longitudinal axis, said longitudinal axes being substantially parallel with one another, and *said generally conical divergent beam and said generally conical convergent detection volume are substantially aligned with said respective longitudinal axis.*

Emphases added.

Independent claim 45 recites [a] method of determining the level of a fluorescent material in a body of water remotely from a fluorometer, the fluorometer comprising an excitation system including an excitation source for producing excitation light capable of causing fluorescence in fluorescent material; and a detection system for detecting said fluorescence, the method comprising:

generating said excitation light using at least one light emitting diode (LED);
causing said *excitation light to project from said excitation system in a generally conical divergent beam*;
using at least one collimating lens to form said divergent beam;

modulating said beam with a modulating signal having a modulating frequency;

receiving light at said detection system and converting said received light into a corresponding electrical signal;

using at least one lens to provide a generally conical convergent detection volume for the detection system, said generally conical detection volume to converging in a direction towards said fluorometer;

causing said generally conical detection volume to at least partially overlap with said generally conical divergent beam;

detecting, in said electrical signal, a signal component of substantially the same frequency as said modulation frequency;

determining the value of a spectral component of said electrical signal corresponding to said modulation frequency; and

determining the level of fluorescent material present in said body of water depending on said value of said spectral component.

Emphases added.

<u>Rejection of claims 1, 4-6, 12, 16, 18, 20, 23, 27-30, 39-42, 44 and 45</u>

Firstly, none of the cited prior art uses an LED light source to detect the level of fluorescent material in a body of water remotely from a fluorometer. Unlike a laser excitation source, the LEDs facilitate the creation of a generally conical divergent excitation beam as claimed in claim 1. This allows the fluorometer to maintain a relatively large detection area (without scanning) extending remotely from the fluorometer. However, a person having ordinary skill in the art would not normally consider using LEDs when detecting fluorescence remotely from a fluorometer because the levels of fluorescence detected at relatively *large* distances from the fluorometer would be relatively *low*. Applicants have found that in order to *increase* the detection range of a fluorometer while maintaining a relatively *large* detection area, a combination of features are required:

i. an LED excitation source;
ii. at least one collimating lens;
iii. a generally conical divergent excitation beam;
iv. a generally conical convergent detection volume;
v. modulation of the excitation beam and corresponding spectral analysis of the received signals; and

vi. determining the level of fluorescent material present in the body of water depending on the value of the spectral component corresponding to the modulation frequency.

All of these features are recited in the independent claims 1, 42 and 45, and they all make an important contribution to reliably detecting levels of fluorescent material at relatively large distances from the fluorometer while maintaining a relatively large detection area. Applicants particularly note that <u>none</u> of the prior art devices are capable of detecting fluorescence at a distance of up to several meters from a fluorometer while maintaining a relatively large detection volume (any of the prior art that uses LEDs as a light source can only detect fluorescence *adjacent* the fluorometer, while those prior art devices that can measure fluorescence at distances of up to several meters from the fluorometer do so using a scanned laser).

Applicants agree with the Examiner that Correa et al. does not disclose the use of LEDs or (that the signal detected by the detection system is processed by) spectral analysis. *See* Office Action page 4. However, Applicants disagree that "[o]ne of ordinary skill in the art would have used LEDs in order to reduce the cost of the device and by using a spectral analysis of the information captured by the detection device in order to more accurately type of fluorescent material being measured" since there would be <u>no</u> reason, incentive or motivation for Correa et al. to make the Examiner asserted modification. In particular, the excitation system of Correa et al. <u>fails</u> to form a beam projecting from the fluorometer that is generally conical and divergent. Instead, the excitation beam produced by Correa et al. is <u>always</u> collimated, i.e. non-divergent. This is because Correa et al. uses a laser as the excitation source, lasers necessarily producing collimated beams that are strictly non-divergent. Indeed, Correa et al. explicitly states that "the system will also function using a pulsed laser source. Still alternatively, the source may be a dye laser, arc lamp or any radiation source of specified wavelength capable of emitting a *collimated* light beam." Emphases added, *see* Correa et al. col. 4, lines 64-67.

Moreover, it can be seen from the optical components of Correa et al. figures 4 and 6-8 (*see* in particular the beam expander 172, the prism 92 and the mirror 94) that Correa et al.'s invention is *specifically configured* for <u>collimated beams such as lasers</u>. For example, it would not be possible to transmit a divergent beam via prism 92 and mirror 94 in the manner disclosed by Correa et al.

In this connection, the Office Action refers to the "beam expander **172**" of Correa et al. as a "collimating lens" that has the effect of forming a generally conical divergent beam. Applicants respectfully disagree. A beam expander is known to persons having ordinary skill in the art as a device specifically for *increasing the diameter of a laser while still maintaining the resulting beam as a collimated (non-divergent) laser beam.* As further evidence of this, Correa et al. discusses numerous times that its optical system scans the laser output across the target area. *See* for example, "scanning optical system then provides *selected directivity* to the laser beam," *see* Correa et al. col. 1, line 68 to col. 2, line 1; "laser scanning mechanism... controlled to repetitively scan across the progression path through an angular excursion of typically 45° to either side of a vertical line," *see* Correa et al. col. 3, lines 62-66; and "as the output scanning beam **62** continually traverses the path," *see* Correa et al. col. 4, lines 62-63. Thus, it is clear that scanning a laser is a common technique and is <u>necessary</u> with respect to Correa et al., specifically because a laser provides such a *narrow, collimated* beam.

Similarly, with regard to the Examiner's assertion on pages 3 and 5 of the Office Action that Fig. 6 of Correa et al. indicates that Correa et al.'s excitation beam is a cone shape, Applicants respectfully disagree. Instead, Applicants respectfully submit that Correa et al. Fig. 6 shows a *scanning* light beam **62** traversing a swath line **182**. *See* Correa et al. col. 7, lines 6-8. This is achieved by tilting the mirror **94** in order to scan the light beam **62**. The output of Correa et al.'s system is the collimated laser beam **62** (which is <u>non-divergent</u> and <u>not conical</u>). Indeed, Correa et al. Fig. 6 shows *two separate instances* of the beam **62** in different scanning positions for the purpose of illustration of the scanning concept. This is further evident by considering Correa et al. Fig. 6 wherein the laser beam **180** is reflected off mirror **94** to create the beam **62**. Clearly, the same beam **180** <u>cannot</u> be reflected off the mirror at two different angles simultaneously, i.e. the Fig. 6 was drawn to show how the angle of the reflected beam 62 can change during the scanning process, depending on the angle of the mirror 94. This can be appreciated from, for example, col. 5, lines 1-3 and col. 7, lines 1-16 of Correa et al. In contrast, the lens system of the instant application provides an "excitation system... comprising means to cause said excitation light to form... a generally conical divergent beam... beam causing means comprising at least one collimating

lens..." as claimed, for example "lens system **5**," described with respect to Figs. 1-3 and achievable only with LEDs, as described in the instant specification.

Therefore, Applicants respectfully submit that, *in contrast to the claimed subject matter*, Correa et al. does not disclose "a generally conical divergent beam," and that Correa et al. is technically incompatible with the production of "a generally conical divergent beam."

Applicants also respectfully submit that Correa et al. fails to disclose "said beam causing means comprising at least one collimating lens," as required by the claims. The Examiner has asserted that beam expander **172** is a collimating lens as recited by the claims. However, as explained above, this is not the case – a beam expander produces a strictly non divergent collimated beam whose diameter is greater than the incident laser's diameter.

Applicants also respectfully submit that, contrary to the Examiner's assertions, the detection system of Correa et al. fails to teach the claimed features of "is arranged to provide a generally conical detection volume for the detection system... converging in a direction towards the fluorometer." *See*, for example, Correa et al. col. 7, lines 22-30, from which it can be seen that the lenses of Correa et al.'s detection system are deliberately focused *at specific locations*, which is the opposite of the convergent conical detection volume recited in claim 1.

Since Correa et al. fails to disclose "a generally conical divergent [excitation] beam," or "a generally conical convergent detection volume" as claimed, Correa et al. cannot possibly disclose the claim 1 features of "said generally conical detection volume... at least partially overlapping with said generally conical divergent beam."

Applicants also respectfully disagree that Correa et al. discloses, teaches or suggests the "detecting means including... means for determining the value of a spectral component of said electrical signal corresponding to said modulation frequency." Emphasis added. In contrast, any spectral analysis performed by Correa et al. (including the passages cited by the Examiner) is an analysis of optical signals and not an analysis of electrical signals as required by claim 1.

Accordingly, claim 1 is novel, unobvious and patentable over Correa et al. et al. by virtue of *at least* the following features:

A. said excitation system comprises an excitation source comprising one or more light emitting diodes (LEDs),

B. means to cause said excitation light to form, in use, a generally conical divergent beam projecting from the fluorometer (therefore diverging in a direction away from the fluorometer),
C. said beam causing means comprising at least one collimating lens,
D. wherein said at least one lens of the detection system is arranged to provide a generally conical convergent detection volume for the detection system, said generally conical detection volume converging in a direction towards said fluorometer and at least partially overlapping with said generally conical divergent beam,
E. said detecting means including means for performing spectral analysis of said <u>electrical</u> signal and means for determining the value of a spectral component of said <u>electrical</u> signal corresponding to said modulation frequency,
F. wherein said detection system is arranged to determine the level of fluorescent material present in said body of water depending on said value of said spectral component (of the electrical signal) such that the fluorometer is capable of detecting fluorescent material located remotely from the fluorometer in said body of water.

Thus, Correa et al. fails to disclose, teach or suggest at least the presently claimed features of *[a] fluorometer for detecting the level of fluorescent material in a body of water*, the fluorometer comprising:

> an excitation system including an excitation source… *comprising one or more light emitting diodes (LEDs)… means to cause said excitation light to form*, in use, *a* generally conical *divergent beam projecting from the fluorometer, said beam causing means comprising at least one collimating lens*
>
> …
>
> wherein said at least one lens of the detection system *is arranged to provide a generally conical convergent detection volume for the detection system, said generally conical detection volume converging in a direction towards said fluorometer* and *at least partially overlapping with said generally conical divergent beam* and wherein
>
> said *detecting means including means for performing spectral analysis of said electrical signal and means for determining the value of a spectral component of said electrical signal corresponding to said modulation frequency*,
>
> wherein *said detection system is arranged to determine the level of fluorescent material present in said body of water depending on said value of said spectral component*, such that the fluorometer is capable of detecting fluorescent material located remotely from the fluorometer in said body of water.

Emphases added.

The Examiner has asserted that one of ordinary skill in the art would have used LEDs in Correa et al.'s apparatus in order to reduce cost. Applicants respectfully disagree. An LED would

not produce a collimated beam such as is required for compatibility with Correa et al.'s optical system, in particular its beam expander **172**, prism **92** and scanning mirror **94**.

The Examiner has asserted that the combined teaching of Correa et al. and Tokhtuev et al. would lead a skilled person to use LEDs in Correa et al.'s device. Applicants respectfully disagree. As discussed above, Correa et al.'s optical system is <u>incompatible</u> with the use of an LED excitation source. Moreover, Tokhtuev et al. teaches the use of LEDs to provide excitation light that is focused to a point <u>very close</u> to the fluorometer sensor itself (see Figure 1 of Tokhtuev et al.). Not only is this technically incompatible with the generally conical divergent excitation beam of claim 1, but it is also technically incompatible with the optical scanning system taught by Correa et al.

The Examiner has also asserted that one of ordinary skill in the art would modify Correa et al. to use spectral analysis in order to more accurately determine the type of fluorescent material being measured. Applicants respectfully disagree. Correa et al. has no need for the spectral analysis of claim 1, at least, because of the relatively high power of its laser, all the necessary detection can be performed by the optical components of its detector.

The Examiner has asserted that one of ordinary skill in the art would combine the teachings of Barringer with Correa et al. such that spectral analysis would be used in the device of Correa et al. as per claim 1. For the reasons stated above, Applicants respectfully disagrees that Correa et al. would use spectral analysis. However, even if Correa et al. were to use spectral analysis as suggested by the Examiner (in order to more accurately determine the type of fluorescent material being measured), or as taught by Barringer to determine which materials are present in the target zone (*see* Barringer col. 1, lines 45-50), this is not how spectral analysis is used in the fluorometer as claimed. Instead, the fluorometer of claim 1 uses spectral analysis to determine the value of a spectral component of an <u>electrical</u> signal that corresponds to the modulation frequency of the excitation beam. In contrast, the spectral analysis referred to by the Examiner and taught by Barringer involves analysis of <u>optical</u> signals (*see* Barringer col. 2, line 60 to col. 3, line 17, discussing "a large aperture polychromator **30**...to disperse the detected light radiation... then directed onto a channel plate light amplification system **32** that intensifies the detected ***optical signal*** and provides a muti-channel readout that is effectively responsive to a series of optical

bands.... Barringer further discusses "light signal" and "light pulse.") in order to determine the composition of the optical signals. The spectral analysis of the (digital) <u>electrical</u> signal recited by claim 1 is used by the fluorometer of claim 1 to detect received light of interest (because LEDs have relatively low power compared to, say, a laser) and is not used to determine the spectral composition of the optical signal.

Accordingly, Barringer does not disclose the claimed features of "means for determining the value of a spectral component of said <u>electrical</u> signal corresponding to said modulation frequency" (emphasis added) and so the combined teaching of Barringer and Correa et al. <u>fail</u> to disclose, teach or suggest *each and every* feature of claim 1.

With regard to the generally conical divergent excitation beam, a person having ordinary skill in the art would not modify Correa et al. such that it produced a generally conical divergent excitation beam since this is <u>technically incompatible</u> with the optical system disclosed by Correa et al. (in particular the beam expander **172**, the optical scanning system that includes scanning mirror **94**, the beam splitter **84** and the prism **92**). Moreover, the concept of a generally conical divergent excitation beam as claimed is <u>fundamentally incompatible</u> with the use of lasers as the excitation source. Applicants further note that "[i]f proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification." *In re Gordon*, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984)

Accordingly, Applicants respectfully submit that Correa et al. et al., Barringer and Tokhtuev et al., whether taken alone or in combination with the Examiner's assertions and the other cited art references, fail to teach, disclose or suggest *each and every* feature of the presently claimed subject matter, as required by *In re Wilson*. Furthermore, the proposed modifications are incompatible with the system of Correa et al. and therefore there can be no motivation to make such modifications, as taught by *In re Gordon*; accordingly, the Examiner has failed to make a *prima facie* case of obviousness.

As <u>all</u> of the features of independent claim 1 are not disclosed, taught or suggested by the cited art, the presently claimed subject matter cannot be rendered obvious by the cited art. Accordingly, it is respectfully submitted that claim 1 is both novel and non obvious in the light of

the prior art. With regard to claims 42 and 45, the same comments apply as were made in relation to claim 1, *mutatis mutandis*.

With regard to claim 42 in particular, Applicant respectfully disagrees that Correa et al. discloses an excitation system and a detection system in separate housings. However, to make the distinction clear, newly presented claim 48, dependent from claim 42, (and newly presented claim 47, indirectly dependent from claim 1) recites that the citation system and detection system are in respective separate housings, each having its own optical window. This is not disclosed by Correa et al., which has a single optical window **60** in a single housing **50** (see Figure 4 of Correa et al.). It would be impossible for Correa et al.'s device to be modified to use two separate housings with respective optical windows since the optical scanning system **94**, **96** will only work if both the transmitted light and the received light are reflected by the same mirror **94**, i.e. Correa et al.'s detection and excitation systems must be in the same housing, using the same mirror **94** and the same window **60**.

Similarly, as the dependent claims necessarily recite all of the features of the independent claim from which they depend, the claims that depend from independent claim 1 are likewise asserted to be patentable over the cited references. Therefore, it is submitted that independent claims 1, 42 and 45 and all the claims depending therefrom (pending claims 4-6, 8, 9, 12, 16, 18, 20-35, 37, 39-41, 44, 46 and 47; claims 43 and 48; and claim 49, respectively, including newly presented claims 46-49 and claims 4-6, 12, 16, 18, 20, 23, 27-30, 39-41 and 44 explicitly rejected herein) are unobvious over the cited prior art of record, whether taken alone or in any combination. Applicants respectfully submit that the dependent claims recite further patentable features.

For example, with regard to claim 4, as indicated above in relation to claim 1, Correa et al. does not produce a divergent cone like excitation beam. Applicant respectfully disagrees with the Examiner's comments in relation to Tokhtuev et al. Specifically, Tokhtuev et al. Figure 1 shows that the Tokhtuev et al. output beam is focused to a point. As such, the excitation source could not be placed at the focal point of the lens system.

Regarding claim 5, as discussed above with respect to claim 1, Correa et al. does not disclose a collimator – component **172** of Correa et al. is a beam expander which is not the same as,

or technically equivalent to, a collimator.

Regarding claim 6, the use of a plurality of LEDs arranged in a one-dimensional rectangular array is technically incompatible with Correa. This is because Correa et al.'s optical excitation system, including the beam expander **172**, the splitter **84**, the prism **92**, the mirror **94** and more generally the concept of an optical scanning system **94, 96**, requires the excitation source to use a focused, collimated laser beam.

Regarding claim 18, as discussed above with respect to claim 1, any analysis performed by Correa et al. (including the analysis cited by the Examiner of Correa et al. col. 10, lines 31-54) is an analysis of <u>optical</u> signals. In contrast, claim 18 relates to the detection of a signal component of an <u>electrical</u> signal.

Regarding claim 20, the same comments apply, *mutatis mutandis*, as for claim 42.

Regarding claim 41, as discussed with respect to claim 42, Correa et al. <u>cannot</u> be modified such that the excitation and detection systems are in separate housings with parallel longitudinal axis. Applicants note that Correa et al. <u>must use</u> the same optical scanning system **94, 96** to transmit and receive light.

<u>Rejection of claims 8, 9, 21, 22, 24-26, 31-35, 37 and 43</u>

Claims 8, 9, 21, 22, 24-26, 31-35 and 37 depend from independent claim 1 and claim 43 depends from claim 42. As discussed above, claims 1 and 42 are patentable over Correa et al. in view of Barringer and Tokhtuev et al. Applicants respectfully submit that <u>none</u> of Bentsen et al., Früngel et al., Kolber et al., Chudnovsky, Field, Zielke et al., and Geiger whether taken alone or in combination with each other or with Correa et al. in view of Barringer and Tokhtuev et al., correct the deficiencies of Correa et al., Barringer and Tokhtuev et al. with respect to the above-discussed patentable features.

Applicants reference and incorporate the discussion above and from the previously filed Response(s) to Office Actions, for example the Reply and Amendment under 37 CFR 1.111 filed July 8, 2010, regarding the deficiencies of these references. The additional art cited by the Examiner is similarly deficient in failing to teach using an LED light source "to determine the level

of fluorescent material... located remotely from the fluorometer in [a] body of water" as claimed.

Claims 8, 9, 21, 22, 24-26, 31-35, 37 and 43 are patentable at least for their dependency from a patentable independent claim; furthermore these claims have patentable features *per se.*

Accordingly, Applicants respectfully request that the rejections under 35 U.S.C. 103(a) be withdrawn.

New claims 46-49

Newly presented claims 46 and 47 depend from claim 1. Newly presented claim 48 depends from claim 42, and newly presented claim 49 depends from claim 45. As discussed above, claims 1, 42 and 45 are patentable over the cited art of record. Claims 46-49 are therefore patentable at least for their dependency from a patentable independent claim; furthermore these claims recite further patentable features *per se.* For example, with regard to the feature "wherein the generally conical divergent beam projecting from the fluorometer is non-scanned," Applicants refer the Examiner to the Background discussion of Applicants' specification, specifically regarding Conoco *explicitly* discussing the drawbacks of "apparatus for detecting hydrocarbons in a body of water, wherein the excitation source comprises a laser which scans the body of water to excite and detect fluorescent materials...because the apparatus is laser-based, it is bulky, expensive and requires a relatively large amount of power. Consequently, such apparatus have restricted use on ROVs (Remotely Operated Vehicles) and particularly AUVs (Autonomous Underwater Vehicles). Moreover, such apparatus suffer from the practicalities associated with health and safety issues surrounding lasers... It would be desirable, therefore, to provide a fluorometer which is capable of remotely detecting fluorescent material, especially in an underwater environment, and which does not suffer from the problems outlined above." Accordingly, Applicants' claimed subject matter addresses and solves the issues of, among others, excitation sources comprising scanned lasers. Applicants respectfully request an early indication of allowability.

CONCLUSION

In light of the foregoing, Applicants submit that the application is in condition for allowance. *If the Examiner believes the application is not in condition for allowance, Applicants respectfully request that the Examiner call the undersigned to expedite further prosecution.*

In the event this paper is not timely filed, Applicants petition for an appropriate extension of time. Please charge any fee deficiency or credit any overpayment to Deposit Account No. 14-0112.

Respectfully submitted,

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